Mobile-based Dental Clinic Application as an Optimal Reservation Control System

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ABSTRACT
Internationally, the health-care sector has been slower than many other sectors in reducing its carbon emissions and broader environmental footprint [1]. Indonesia, currently the fourth most populous country in the world and home to 65 million adolescents, has experienced rapid socio-economic development and urbanisation which has driven a rapid epidemiological transition [2] Adolescents in Indonesia now face a complex burden of disease which beyond a persisting burden of communicable diseases includes a rapidly increasing burden of non-communicable diseases, injuries and health risks [3] . The level of health in Indonesia is still relatively low, especially dental health. Patients require dental treatment to alleviate discomfort, provide regular oral-health examinations [4]. Dental clinics can help people become more aware of the importance of maintaining healthy teeth. This research identifies how to design and implement a system that will be used by doctors and patients. Information about dental clinics can be accessed online through a mobile-based dental clinic application. This research has several services such as information services and reservation services. This research was developed using the Dart and PHP programming languages, as well as the Flutter and Laravel frameworks.

General Terms
Android, Flutter, Laravel, Dart, PHP

Keywords
Mobile Application, Dental Clinic, Reservation

1. INTRODUCTION
Oral health related quality of life (OHRQoL) is an integral part of the general health and well-being of an individual [5]. The results of the Basic Health Research (Riskesdas) in 2018 showed that 57.6% of the Indonesian population experienced oral problems and only about 10.2% had received medical services [6]. The level of public health is influenced by medical services. From motivating patients to documenting their data, creating digital reports, as well as planning dental check-ups with mobile-based dental applications to optimize digitization and technology utilization in dental health [7].

Reservation or booking is not a new concept [8]. The problem in dental clinics is that patient data recording is still done in writing and processed in a ledger. Transaction data includes numeric values of the transactions and the date/time when the transactions are recorded, and textual data such as descriptions [9]. To address the problem, this research proposes reservation control strategies [10] in dental clinics using mobile technology. Mobile commerce has emerged as a vital tool for many firms as smart phones continue to evolve and gain in popularity, it offers customers accessibility, enabling them to purchase products or services at anytime, from anywhere [11]. Mobile-based dental clinic applications provide reservation services and provide information to patients related to dental health.

Much of the research in software engineering has focused on developing methods, techniques and tools, and much less research on exploring the foundations of software engineering, including identifying fundamental principles [12]. This research identifies how to design and implement a new system to create a mobile-based dental clinic application for optimal reservation control, where the users are doctors and patients. Users are precious, they experience breakdowns and develop workarounds, sometimes innovative ones, and they have needs, wants, and opinions [13]. Doctors manage service information, doctor data, patient data, examination schedules, and total examination fees. The patient can manage personal data, selected services, and examination schedules. The reservation service will be successful with one click on the application. Therefore, mobile smartphone applications are critical to support the functions and displays that have been designed [14]. Plan-driven software development approaches prefer a hierarchical control and command team structure [15]. This research was developed using the agile software development method. In general, the agile software development method is used to produce applications with good quality by prioritizing user satisfaction through rapid and gradual application development.

2. RESEARCH METHOD
The way the system works can be visualized in architecture diagram in Fig 1.
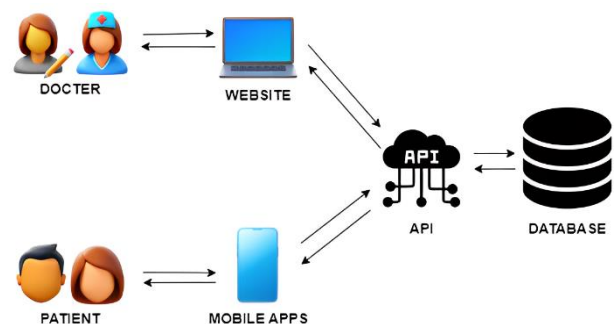

Fig. 1 Architecture Diagram

This research are designed and developed to perform specific tasks for their potential use. System will be used by doctors and patients. Doctors can manage data with the website, while patients use the mobile application. Data on the website and mobile application can be stored in the database through the Application Programming Interface (API). The term Application Programming Interface (or API) consists of a software interface with the purpose of facilitating the communication between different components or systems [16]. Relational Database MySQL is used to organize the data relationship model in the system.

2.1 Data Collection Procedure

Data was obtained using 3 stages, namely the direct observation stage, the interview stage, and the literature study stage.

2.1.1 Direct Observation (Observation)

Data collection is done by conducting direct observations at the HDC Aesthetic Dental Clinic located in Temanggung. Observations were made by observing services such as reservations and examinations available.

2.1.2 Interview

Data collection is done through interviews with drg. Hedda Aulia Pratiwi as the owner of HDC Aesthetic Dental Clinic directly. The things that were asked or the contents of the interview were about the number of doctors available, the doctor's practice schedule, the reservation process, and the patient examination process. Observation aims to make researchers understand what is needed by the Clinic regarding the system to be created.

2.1.3 Literature Study

This stage consists of collecting theories as a research guide, making observations to analyze the data needed.

2.2 System Design Logic

Logic design is a sketch of the data processing process and a description of the system presented through diagrams including DFD (Data Flow Diagram) as a data flow method. Systems are represented using diagrams as a network of functional processes connected to each other through data flows, either manually or computerized. The data design process uses DFD (Data Flow Diagram) which is divided into context diagrams, level diagrams, level 1 DFD and level 2 DFD. Before the DFD is created, a context diagram is needed to explain the flow of data transfer from patients and doctors. The data will be received and processed by the system.
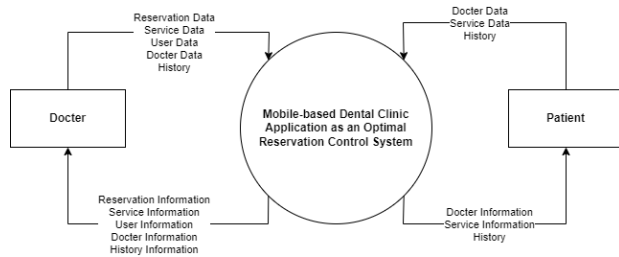

Fig. 2 Context Diagram

In Fig 3, it can be seen that there are DFD components consisting of processes, flows, warehouses, and terminators. There are 4 processes and 2 data warehouses in the system. The processes are login, master data, transactions and history. The data warehouse consists of patients and doctors. The flow in the diagram explains the distribution of patient data, doctor data, service data, reservation data, patient information, reservation information, doctor information, and service information.
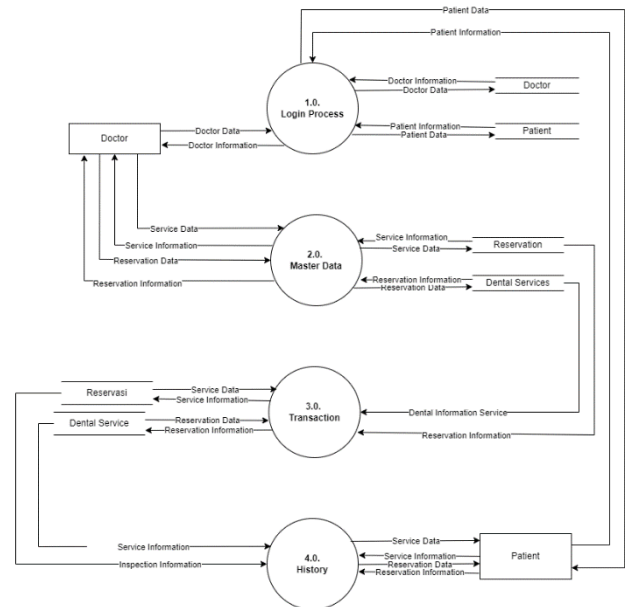

Fig. 3 Data Flow Diagram

2.3 Physical Design

The relationship between tables is depicted with lines that are interconnected between each table. The line is the relationship between the primary key and foreign key of the table.
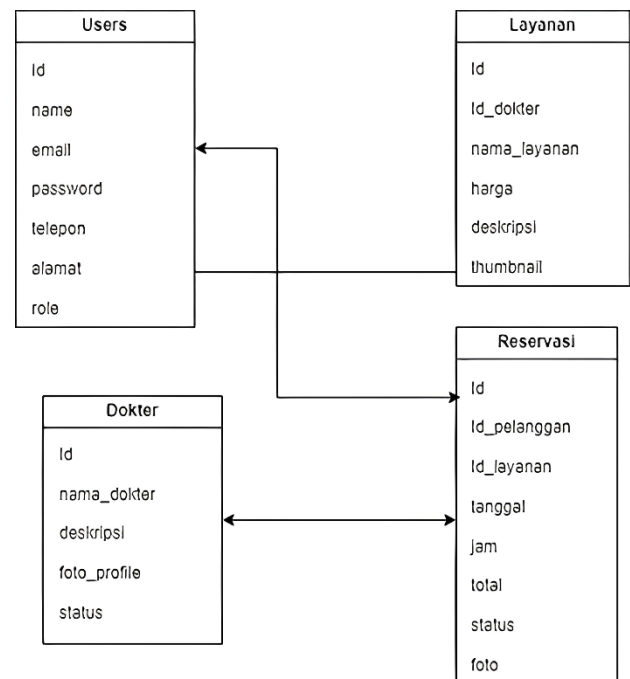

Fig. 4 Relations Table

2.4 Interface Design

The application framework was developed using Figma and Whimsical to create low fidelity. The website interface design used by the admin has several views. The views that will be used are designed as well as possible to help user convenience.
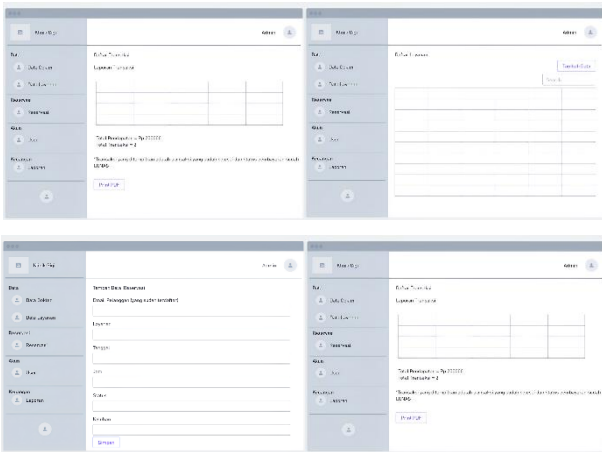
Fig. 5 Wireframes Website Apps

The interface design of the mobile application used by patients has several views. patients can get service information, a list of doctors, and selection of examination schedules.
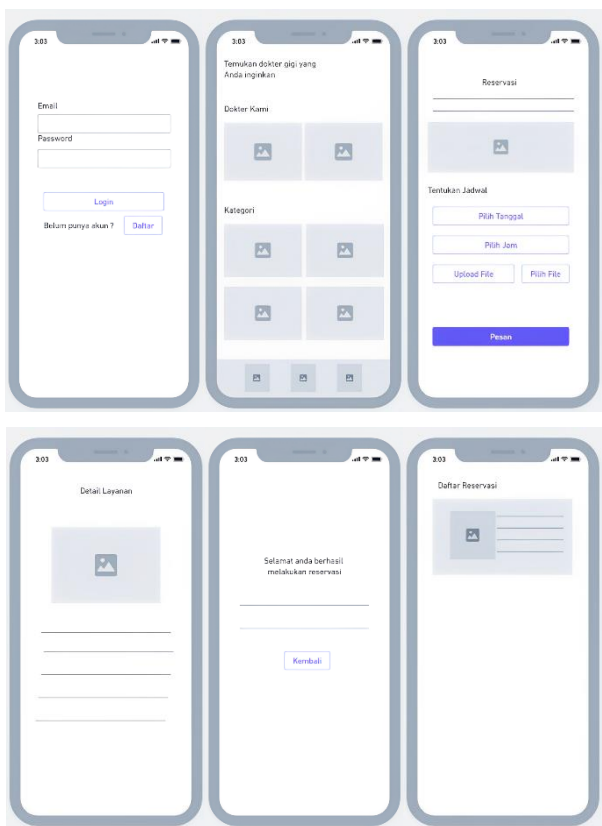

Fig. 6 Wireframes Mobile Apps

3. RESULT AND DISCUSSION

3.1 Assumptions

Application users are dental clinic patients who can operate a smartphone. Patients can make reservations as well as consult with doctors through the application. Patients who make reservations will get proof in the form of a referral code. Meanwhile, the doctor can find out the patient's reservation data through the website application. The clinic is open from 08.00 to 20.00. Therefore, patients are expected to arrive 1 hour earlier before the examination time. If the doctor is on leave, the doctor's availability schedule can be changed through the website app, so patients cannot make reservations with doctors who are not available on the mobile app.

3.2 Hypothesis

This hypothesis is based on assumptions obtained and proven in the research stage. This research hypothesizes that "Mobile-based Dental Clinic Applications can make it easier for doctors to support their performance and patients to make reservations easily and optimally".

3.3 Feature

There are several features provided by the system for doctors and patients. These features are made to facilitate the performance of doctors in serving patients at the clinic. Here are some parts of the application.

Table 1 List of Feature

No	Actor	Description
1.	Patient	user login page, registration page, profile page, service list page, service detail page, reservation data content page, successful reservation page, failed reservation notification page, reservation detail page, and transaction list page.
2.	Doctor	admin login page, dashboard page, doctor list page, add data page, doctor data action page, service list page, add service data page, reservation list page, add reservation data page, user list page, add user data page, report page, transaction data page, and print report page.

3.4 Run an Experiment

After the wireframe is successfully created, the next step is to do the coding. Mobile applications for patients use the dart programming language and flutter framework, while website applications for doctors use the PHP programming language and laravel framework. Through these endpoints the user can carry out certain actions such as creating, reading, updating, or deleting (CRUD) data.
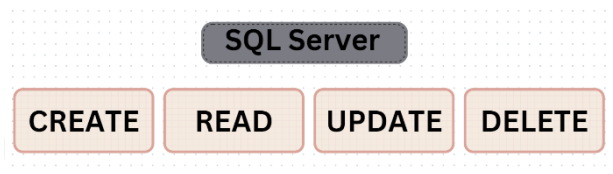

Fig. 7 SQL Server

Patients also tested by creating a new account and then making a reservation. After the demo and preview session, a question and answer session was held to get feedback and suggestions. The suggestion obtained was the lack of features to make online payments.

3.5 Implementations

Implementation of the system that has been designed and finished coding in the form of website applications and mobile applications. Here is the design of the application.

3.5.1 Login Page

The Admin Login page is the initial page when logging into the application. Admins are expected to enter their registered email and password. After that the admin can login.
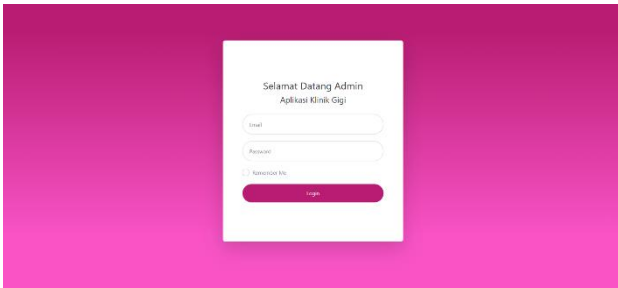
Fig. 8 Login Page

3.5.2 Admin Dashboard Page

The admin dashboard page can be visited if the admin has successfully logged in. In the dashboard there is a menu of doctor data, service data, reservations, users, and reports.
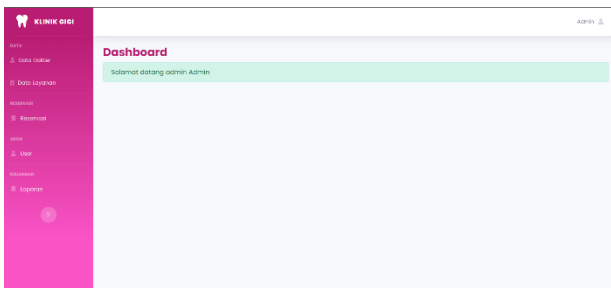

Fig. 9 Admin Dashboard Page

3.5.3 Doctor List Section Page

In the doctor list section, the admin can add data, edit data, and delete data.
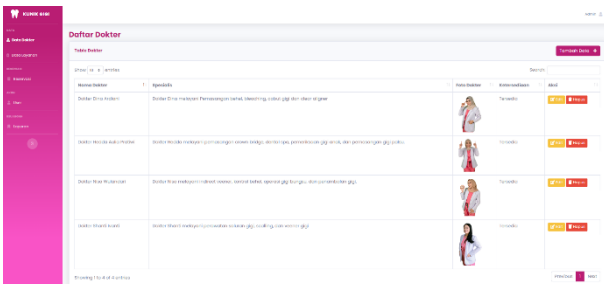

Fig. 10 Doctor List Section Page

3.5.4 Data Add Page

This page is used to add doctor on duty data. Admins can enter the doctor's name, doctor's photo, and a description of the services performed by the doctor.
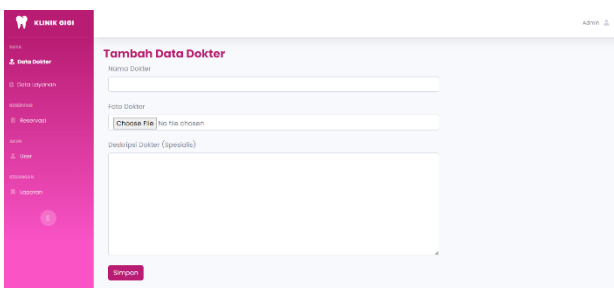

Fig. 11 Data Add Page

3.5.5 Doctor Data Action Page

On the Doctor Data Action Page, the admin can update the latest data in the form of doctor availability status. If the doctor is on vacation then the availability status becomes Unavailable.
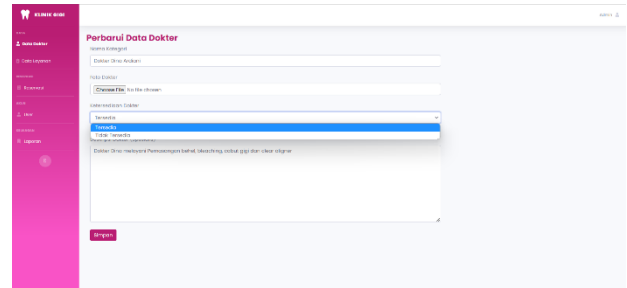

Fig. 12 Doctor Data Action Page

3.5.6 Service List Page

The service list page presents the types of services available. On this page, the admin can add data, edit data, and delete data.
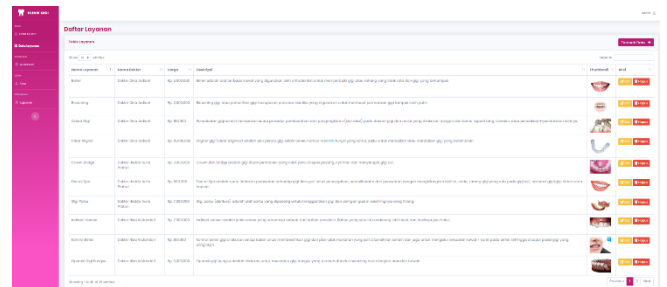

Fig. 13 Service List Page

3.5.7 Add Service Data Page

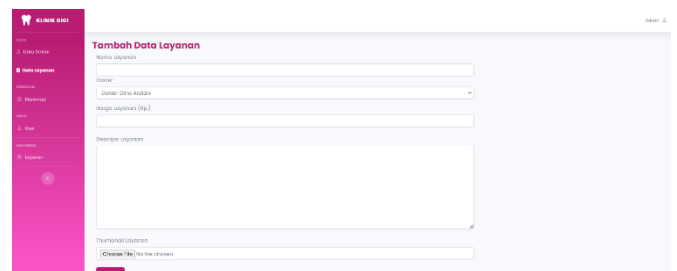This Add Service Data page is used to update the available service type data

Fig. 14 Add Service Data Page

3.5.8 Reservation List Page

This Reservation List page displays several patients who made reservations. The data is equipped with a reservation id, patient name, type of service selected, date and time of examination, total cost, and examination status.

Fig. 15 Reservation List Page

3.5.9 Add Reservation Data Page

This Reservation List page displays several patients who made reservations. The data is equipped with a reservation id, patient name, type of service selected, date and time of examination, total cost, and examination status.
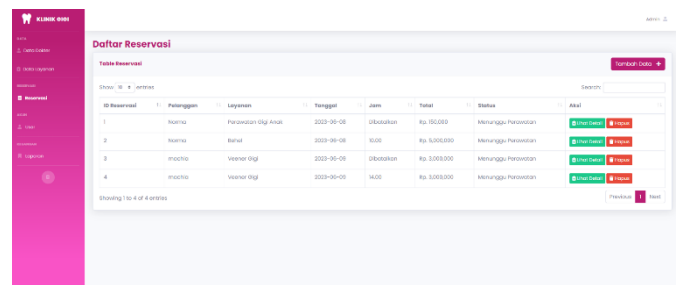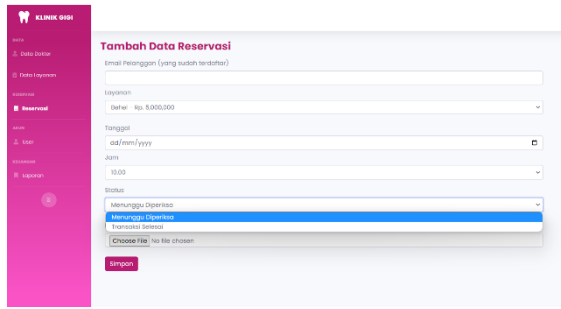
Fig. 16 Add Reservation Data Page

3.5.10 Users Data Page

This page presents a list for application users, namely admins and patients.
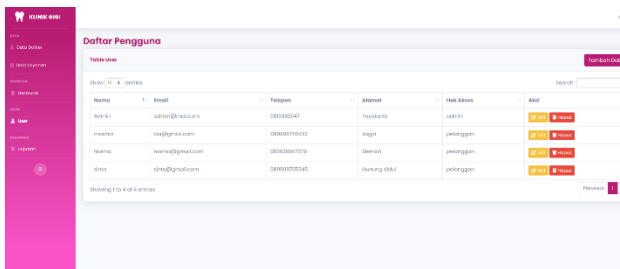

Fig. 17 Users Data Page

3.5.11 Add Users Data Page

This page serves to add user data. Through this page, access rights can be changed.

Fig. 18 Add Users Data Page

3.5.12 Report Page

This report page can be used to count the number of checks performed against a specific date range.
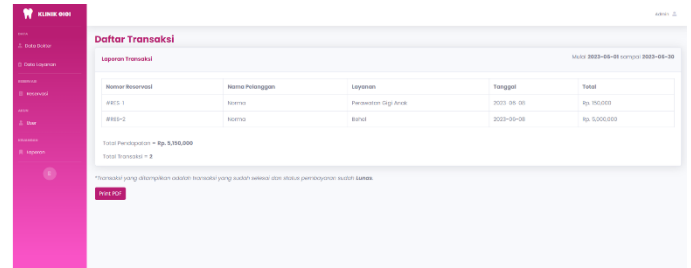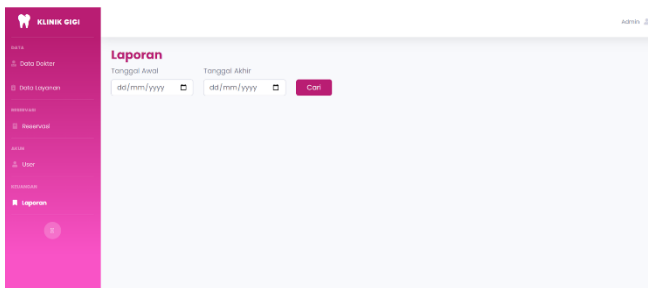

Fig. 19 Report Page

3.5.13 Prints Report Page

This page generates reports in the form of .pdf format that can be printed.
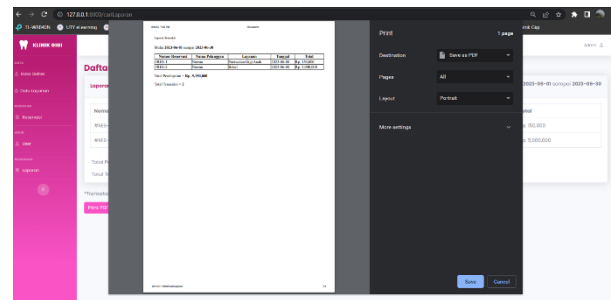

Fig. 20 Prints Report Page

3.5.14 Home Page and Login Page Users

The Home page is the first page that opens when the application is run. On this page there is a list of doctors on duty and a list of available services. There are 3 menus namely Home, Transactions, and Profile. Login can be done by entering your email address and password. If you don't have an account yet, you can register by clicking Register.

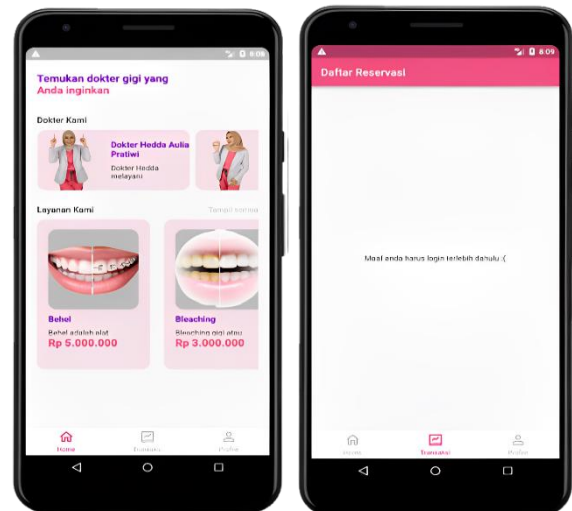**Fig. 21 Home Page and Login Page Users**

3.5.15 Registration Page and Profile Page

The registration page must be filled in with the correct personal data, this is because patient data recap will be done using the registered account. The Profile page will appear when you have successfully logged in. On this page is the help and security center. Through this page, account logout can be done.
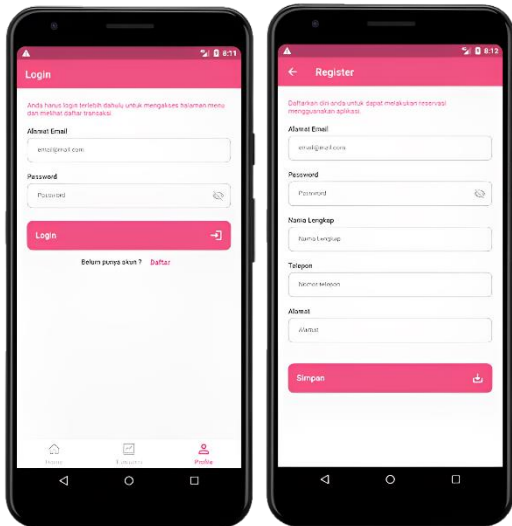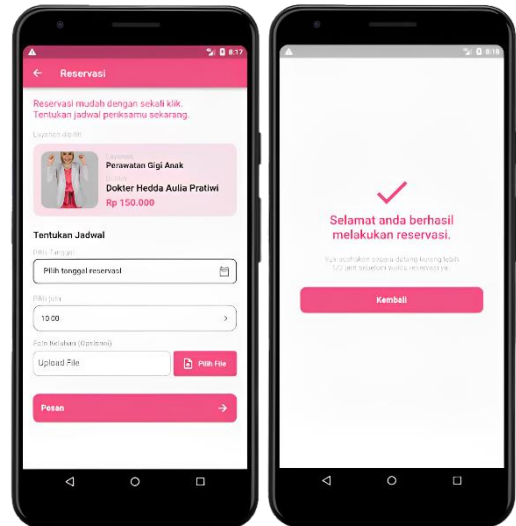
Fig. 22 Registration Page and Profile Page

3.5.16 Service List Page and Service Detail Page

On this page there is a list of available services. Service prices can also be known directly. The Service Details page displays the description and price of the service. To make a reservation, click Book.
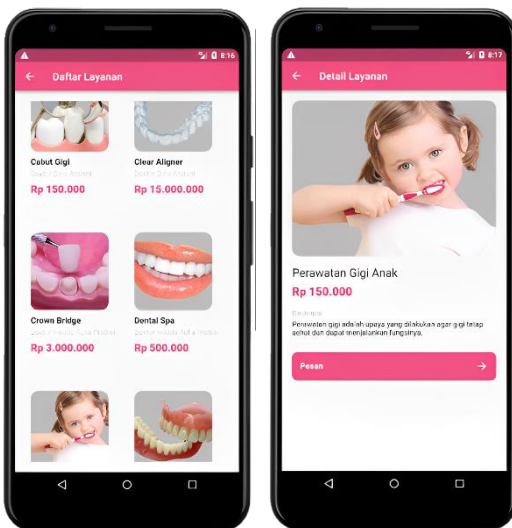

Fig. 23 Service List Page and Service Detail Page

3.5.17 Reservation Data Fill Page and Successful Reservation Page

This Reservation Data Fill page is needed to determine scheduling. Photos of complaints can be uploaded on this page to make it easier for the doctor to immediately arrange action. A successful reservation will be recognized through the notification page on the app.

Fig. 24 Reservation Data Fill Page and Successful Reservation Page

3.5.18 Failed Reservation Notification Page and Reservation Details Page + Cancel Reservation Page

If the selected schedule is not available, there is a pop up notification so that rescheduling can be done by choosing a different time. This page contains proof of a successful reservation. Patients are expected to show proof at the time of examination. Reservations that have been scheduled can be canceled by clicking Cancel Reservation. So that a Canceled sign will appear in the transaction menu.
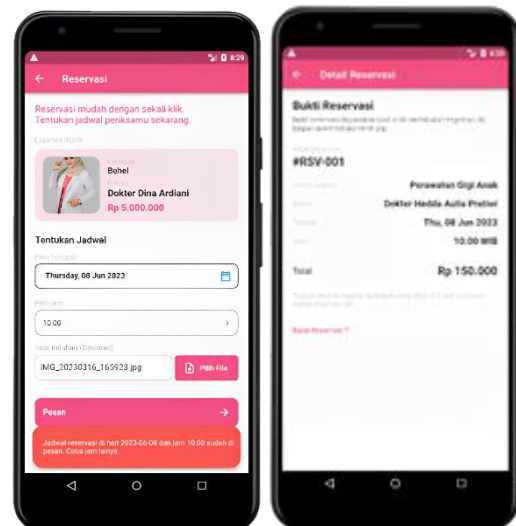
Fig. 25 Failed Reservation Notification Page and Reservation Details Page + Cancel Reservation

3.6 Discussion of Result

The next stage is testing or testing which aims to ensure that every function in the system can run as it should. The test used at this stage is black box testing. Most of the black box approaches proposed for testing RESTful APIs focus solely on creating test cases based on the API specification, often in OAS format, most of them rely on fuzzing to generate random test data with the aim to find bugs [17]. This black box testing is done to look for errors in functions that are damaged or faulty. Errors sought include

software interface errors, performance errors, data structure errors, and initialization or termination errors. Feature interaction set in black box model detected by high-dimensional model representation-based method [18]

Table 2 Black Box Testing Mobile Apps

Testing Activities	Expected realization	Testing Results	Conclusion
Account registration	Patients can create a new account	Can login to the main feature after successfully registering and entering the registered email and password	Accepted
Service data access	Display detailed service data information	Display service data according to the selected service type.	Accepted
Reservation	Can make reservations according to the selected service	Successfully book the selected service	Accepted
Display the transaction list	Display a list of transactions that have been made	Display the transaction list	Accepted
Canceling a reservation	Transaction canceled	The transaction is canceled according to the selected transaction	Accepted

Table 3 Black Box Testing Website Apps

Testing Activities	Expected realization	Testing Results	Conclusion
Account registration	Doctors can create a new account	Can login to the main feature after successfully registering and entering the registered email and password	Accepted
Service data access	Can create, read, update, and delete (CRUD) service data, doctor data, user data, reservation data, and report data.	Can generate new data that has been modified.	Accepted
Reservation	Can change	Successful	Accepted
	the check action from unchecked to checked	change action	
Display the transaction list	Successfully display the transaction list and print the report	Display the transaction list and print the report	Accepted
Canceling a reservation	Transaction canceled	Canceled transactions can be viewed on the web	Accepted

In this research, doctors and patient are needed as users. Both have been tested in using the application. Based on the black box testing that has been carried out, the results show that "Mobile-based Dental Clinic Application as an Optimal Reservation Control System" are **Accepted.**

4. CONCLUSION

According to research related to mobile-based dental clinic applications as an optimal reservation system, it is concluded that the reservation system in the application has been able to answer the previous problem. Regarding code-based proof of transaction and reservation cancellation located on one page. With the web-based application for admin, it facilitates the CRUD (Create, Read, Update, Delete) process of the required data. In addition, the concept of mobile applications for patients with web applications for admins is able to display data changes in real time.

This research has not focused on the concept of payment. So further research needs to develop a good payment system. In addition implementation of the new reservation and consultation system can improve the previous system design. Based on the results of black box testing, the application is **Accepted**. It can be concluded that users can use the application well and understand the design applied to the application.

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